

WHAT IS CLAIMED IS:

1. A method for facilitating airborne free space optical communications between an airborne host platform and a link platform, each platform having an optical head which transmits and receives data via modulated infrared laser beams, wherein the host comprises at least an optical head having a fine, coarse, and ultrafine steering element configured in a cascaded three-tier steering element architecture, the method comprising:
 - obtaining a priori of pointing information from a network to identify a location of the link platform;
 - transmitting a beam directed to the link platform;
 - adjusting the coarse steering element to point the beam to the link platform within a first specified range of measured units;
 - locating a beacon of the link platform; and
 - dynamically focusing the beam to collapse the divergence of the transmitted beam down to a second specified range of measured units less than the first to facilitate tracking.
2. The method according to claim 1, wherein the first specified range of measured units is about 200-500 μ rad.
3. The method according to claim 1, wherein the second specified range of measured units is about 100 μ rad.
4. The method according to claim 1, further comprising tightening a field of regard for each successive tier within the cascaded three-tier steering element architecture to allow for finer steering resolution.
5. The method according to claim 1, wherein the coarse-steering element has a first field of regard, the fine-steering element has a second field of regard less than the first field of regard, and the ultrafine-steering element has a third field of regard less than the second field of regard.
6. The method according to claim 1, wherein the coarse-steering element has a first bandwidth, the fine-steering element has a second bandwidth greater than the first bandwidth, and the ultrafine-steering element has a third bandwidth greater than the second bandwidth.

7. The method according to claim 6, further comprising correcting jitter utilizing a finest tilt parameter at the third bandwidth.
8. The method according to claim 1, wherein the coarse-steering element covers a range of about +/- 45 degrees at about 20 Hz, the fine-steering element covers a range of about +/- 3 degrees at about 200 Hz, and the ultrafine-steering element covers a range of about +/- 100 μ rad at about 2000 kHz.
9. The method according to claim 1, wherein dynamically focusing includes defocusing the beam by utilizing an adaptive-optical element.
10. The method according to claim 11, wherein the adaptive-optical element is a deformable mirror.
11. The method according to claim 1, further comprising transitioning to a tracking mode wherein the link platform's transmission beam is used as a beacon.
12. The method according to claim 11, wherein during the tracking mode the beacon of the link platform remains within a field of regard of the coarse-steering element and fine-steering element by using a fine track sensor.
13. The method according to claim 1, further comprising utilizing a nested control loop to dovetail both fields of regard and command response times of the fine, coarse, and ultrafine steering elements to control jitter.
14. The method according to claim 13, wherein the nested control loop receives the priori of pointing information from the network and accounts for dynamic focusing during acquisition.
15. The method according to claim 13, wherein the nested control loop includes an outer nested loop and an inner nested loop, and wherein the outer nested loop controls the coarse-steering element and fine-steering element and the inner nested loop controls the ultrafine-steering element.
16. The method according to claim 15, further comprising utilizing a fine-tracking sensor for anchoring the coarse-steering element and the fine-steering element, and utilizing a wavefront sensor to anchor the ultrafine-steering element.
17. The method according to claim 16, wherein the ultrafine-steering element is an adaptive-optical element comprising a deformable mirror anchored to a wavefront sensor comprising curvature sensor.

18. The method according to claim 17, wherein the ultrafine-steering adaptive-optical element further relies on its own dedicated controller for commanding the deformable mirror based on acquisitions of the wavefront sensor.
19. An optical head for a free space optical communications system, said optical head utilized for transmitting and receiving modulated infrared laser beams, said optical head comprising:
 - an optical amplifier;
 - a circulator;
 - an ultrafine-steering element;
 - a fine-steering element;
 - a coarse-steering element; and
 - a fine track sensor
20. The optical head according to claim 19, said ultrafine steering element comprising an adaptive-optical element.
21. The optical head according to claim 20, said adaptive-optical element comprising a deformable mirror.
22. The optical head according to claim 20, said adaptive-optical adapted to utilize a high-speed curvature sensing technique.
23. The optical head according to claim 22, said adaptive optic element adapted to be dynamically focused and defocused.
24. The optical head according to claim 19, said ultrafine-steering, fine-steering, and coarse-steering elements configured in a cascaded three-tier steering element architecture.
25. The optical head according to claim 24, wherein for each successive tier within the cascaded three-tier steering element architecture, a field of regard may be tightened allowing for finer steering resolution.
26. The optical head according to claim 19, wherein said coarse-steering element has a first field of regard, said fine-steering element has a second field of regard less than the first field of regard, and said ultrafine steering element has a third field of regard less than the second field of regard.
27. The optical head according to claim 19, wherein said coarse-steering element has a first bandwidth, said fine-steering element has a second bandwidth greater than said

first bandwidth, and said ultrafine-steering element has a third bandwidth greater than said second bandwidth.

28. The optical head according to claim 27, wherein jitter correction relies on a finest tilt parameter at the third bandwidth.

29. The optical head according to claim 19, wherein said coarse-steering element covers a range of about +/- 45 degrees at about 20 Hz, said fine-steering element covers a range of about +/- 3 degrees at about 200 Hz, and said ultrafine-steering element covers a range of about +/- 100 μ rad at about 2 kHz.

30. The optical head according to claim 19, said optical amplifier comprising an erbium-doped fiber amplifier (EDFA).

31. The optical head according to claim 19, a common optical path that supports both transmitted and received beams between said circulator and said ultrafine-steering element.

32. The optical head according to claim 19, further comprising a beam splitter arranged between said ultrafine-steering element and said fine-steering element.

33. The optical head according to claim 32, said beam splitter rated for beams having a wavelength of about 1.55 μ m

34. The optical head according to claim 20 said fine track sensor positioned to receive beams from said beam splitter.

35. The optical head according to claim 34, wherein said fine track sensor along with said coarse-steering and fine-steering elements are utilized to track a link platform.

36. The optical head according to claim 19, said fine-steering element comprising a fast-steering mirror.

37. The optical head according to claim 19, said coarse-steering element comprising an electro-opto-mechanical assembly.

38. The optical head according to claim 34, further comprising a pointer/tracker controller electrically connected to said ultrafine, fine, and coarse steering elements and to said fine tracker sensor.

39. The optical head according to claim 21, wherein the ultrafine-steering element further comprises an embedded wavefront sensor and controller.